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INFORMATION OBTAINED FROM HIGH ALTITUDE COMBAT VETERANS

This report summarizes the information obtained from questionnaires completed by high altitude combat veterans. The purpose of this project is to obtain an accurate conception of the problems relating to the use of oxygen in combat, in the hope that such information might be of value to the training program.

MATERIAL

The material for analysis consisted of 291 completed questionnaires. Inasmuch as this headquarters is concerned with training of crews for operational flights over 20,000 ft. in B-17's, it was deemed appropriate to include in our analysis only the questionnaires of personnel who fulfilled the following criteria:

1. Crew member of a B-17.
2. Flew at altitudes of 20,000 ft. or more in combat.
3. Flew 5 or more missions on demand oxygen equipment.

There were 60 questionnaires which did not meet the above requirements, leaving 231 crew members as the source of information relevant to the use of oxygen in combat by B-17 crews. The breakdown by crew position is as follows.

Pilots	19
Bombardiers	0
Navigators	7
Top turret gunners	45
Radio operators	31
Ball turret gunners	27
Waist gunners	52
Tail gunners	34
Mixed gunners	16

"Mixed gunners" refers to those gunners who had served at two or more positions during their combat experience, and did not indicate which was their principal crew position.

The total sorties numbered about 3100, 900 of which were flown by the officers, the remainder by the enlisted personnel; all of them were in the European Theatre of Operations.

FINDINGS

The information which is of significance for the oxygen indoctrination program may be dealt with point by point as elicited in the questionnaire.

1. At what altitude did you usually begin taking oxygen? The range was 8,000 to 12,000 ft., with the overwhelming number of crews taking oxygen at 10,000 ft. as directed by the pilot or by one of the officers designated by him to be

responsible for oxygen discipline. Furthermore, it was noted by a considerable number of the men, particularly gunners, that the taking of oxygen from 10,000 ft. was of great practical importance in avoiding easy fatigability during the strenuous parts of the mission. It would appear, then, that bomber crews are well indoctrinated on this point.

2. What was the average altitude of your bombing missions? The purpose in asking this question was to formulate some idea of what operational altitude we are training for, and what indications there might be as to changing tactics. Upon our knowledge of such questions can be based a training program which will better prepare the crews for the conditions they will probably meet in combat.

The average bombing altitude was therefore analyzed according to the period in combat, with the following results:

TABLE I

Average Altitude of Bombing Missions

PERIOD	% of Men Flying at Average Altitude of:		
	20-22000	23-25000	26-28000
1942-43	21	68	11
1943	15	68	17
1943-44	25	63	12

It would appear that if there is any impression to be obtained from these figures, the bombing altitude is predominantly around 24,000 ft. and that there has been no significant change in this respect in the past three years. One of the most important aspects of this information for us lies in the fact that we are training our crews at 20,000 ft. and it must be very effectively impressed on them that the difference in oxygen requirement between 20,000 and 24,000 is out of all proportion to the relatively small increase in altitude. This problem can be dealt with quite effectively in the altitude chamber.

3. What was the average number of hours on oxygen of your missions? The importance of this and the following question is the same as mentioned for the preceding question.

The figures show that the trend has been definitely in the direction of longer durations on oxygen.

TABLE II

Average Duration on Oxygen of Bombing Missions

PERIOD	% of Men Flying Indicated Average Hours on Oxygen				
	2-3	3-4	4-5	5-6	More than 6
1942-43	22	37	35	4	2
1943	14	32	44	10	0
1943-44	4	22	45	24	5

The two obvious factors concerned in the duration on oxygen are (1) the distance to the target, and (2) the point in the mission when altitude is reached. In regard to the second factor, there is the consideration whether the route to the target is mainly over water or over land. At any rate, any changes in the direction of increased duration on oxygen require that the training program prepare the crews with an awareness for the necessity of conserving the oxygen supply.

4. What is the highest altitude you have flown in combat? The interesting and informative aspects of the replies to this question are that the great majority of crewmen reach, at some time during their combat tour, those altitudes where "bends" are known to become a problem.

TABLE III

Highest Altitude Flown in Combat

PERIOD	% of Men Who have Reached Altitudes of				
	26-28000	28-30000	31000	32000	More than 32000
1942-43	13	57	13	7	10
1943	14	49	18	13	6
1943-44	16	50	19	9	6

5. What type of oxygen equipment did you use? The figures obtained on this question indicate the rapid rate of elimination of the constant-flow system.

TABLE IV

Type of Oxygen Equipment Used

PERIOD	% of Men Using	
	Constant-Flow Only, Mostly, or Equally	Demand Only or Mostly
1942-43	81	19
1943	30	70
1943-44	12	88

6. Did you ever run out of oxygen except as a result of enemy action? Explain. The aim of this question was to determine whether lack of sufficient oxygen was ever a factor preventing completion of the flight as planned. It was found that total depletion of oxygen does occur occasionally, due to one of two principal causes: (1) A leak in the supply lines, so slow as not to justify a turnback but enough to waste a good part of the oxygen supply; (2) missions of such duration at altitude that the normal supply is insufficient.

7. Was it ever necessary for your plane to turn back from a combat mission because of trouble with oxygen equipment? In asking this question we were concerned with turnbacks resulting from errors on the part of the personnel. In this category the following causes were elicited:

(1) The ball turret recharger hose not being properly stowed, so that it is caught in the turret gear and torn.

(2) Rapid depletion of oxygen by failure to close all emergency valves or by excessive use of emergency valve by apprehensive crew members.

(3) Oxygen system charged with some other gas.

(4) "Leaking regulator." We include this as a probable human error because some crew members mentioned that the trouble was probably due to the diaphragm sticking with the demand valve open, and that if the crewmen were aware of this they could correct it by simply pulling back the diaphragm.

8. Have you ever been troubled by freezing of the demand mask? If so, what part of the mask was involved?

This was one of a number of questions asked in an attempt to determine to what extent the problems as to the design and function of oxygen equipment vary with the respective crew positions. Here again we are handicapped by insufficient numbers of men to allow a clear picture, but the trends may be of some help. Only the A-10 series of masks is covered by these figures. The site of freezing was stated almost without exception to be the exhalation ports, and the problem consisted simply of repeated manipulation of the mask housing to keep the ports clear.

TABLE VII

Incidence of Freezing of Demand Mask

POSITION	% EXPERIENCING ICE-FORMATION IN MASK
Pilots	15
Navigators	0
Top Turret	12
Radio Operator	38
Ball Turret	50
Waist Gunner	56
Tail Gunner	25

9. By whom was your mask checked periodically for fit?

TABLE VIII

Mask Checking in Crewman in Combat in 1943-44

INDIVIDUAL CHECKING	% CREW MEMBERS
Flight Surgeon	13
Personal Equipment Officer	15
Other	2
No one other than self	70

These figures bear out a recent report from the School of Aviation Medicine, that in the ETO, the chief concern is with the initial fit, and that no schedule of periodic checking is practicable or necessary.

10. Did you carry a spare, personally fitted mask on combat missions?

Forty percent of the men carried a personal spare mask; in most of the remaining questionnaires, it was indicated that two or three extra masks were carried in the radio room.

11. Did you make minor adjustments of your mask to your face from time to time during flight?

The purpose of this question was to assess the value of a careful fitting at ground level to the point of achieving a low Scholander test, as compared to the development of some simple practical procedure by which the crew member may check his own fit at altitude. Thus, 50% of the men questioned were inclined to make adjustments to the extent of tightening or loosening straps, wiggling the mask around to relieve pressure on the nose, removing the mask to wipe out moisture of secretions, etc.

12. To what part of your clothing did you anchor the oxygen hose clamp?

Crewmen generally made it a point to attach the oxygen hose clamp; about 50% of ball turret gunners did not attach the clamp for obvious reasons, and a few waist gunners did not attach it because it reduced their range of movement.

Five percent of the men added to their clothing some special tab for the purpose of fastening the oxygen hose clamp; another 5% fastened it to the arm hole of the flak suit. The great majority of the men indicated one of three sites of attachment, with the analysis by positions as follows:

TABLE IX

Sites of Attachment of oxygen hose clamp:

Pilots	Mae West; parachute harness
Navigators	Flap of jacket; Mae West
Top turret gunner	Flap of jacket; Mae West, chute harness
Radio operator	Parachute harness; jacket flap
Ball turret	Chute leg straps; bottom of Mae West
Waist gunner	Mae West; chute strap; flap of jacket
Tail gunner	Mae West

13. Under what circumstances did you have occasion to use the emergency valve?

TABLE X

Use of Emergency Valve

Figures indicate percent of total number of men for each crew position

POSITION	NEVER USED EMERGENCY	REVIVAL	EXERTION	REGULATOR	FIRST AID
Pilot	70	10	5	5	10
Navigator	50	10	20	10	10

Top Turret	50	9	25	9	7
Radio	43	31	13	5	8
Ball Turret	60	13	24	3	0
Waist	51	20	16	6	7
Tail	72	3	25	0	0

Isolated uses of the emergency valve were: "on ascent to prevent bends"; "bouncing ball flow indicator stuck"; "intermittently, to pep me up"; "pneumonia", and "flying fatigue."

14. Did you make it a point to clamp the walk-around bottle to your clothing when using it? If not, please state why not.

From 20 to 30% of the crew members (and the proportion is about the same when analyzed by position) did not fasten the walk-around bottle for the following chief reasons:

(1) It has to be loose so it can be shifted around in getting past obstructions.

(2) It has to be recharged so often, it isn't worth the bother to clamp it.

(3) It might be necessary to change to the main line or to another bottle in a hurry.

(4) When it is clamped you can't see the gauge, so you don't know if you are running low.

15. Do you think the walk-around bottle has sufficient duration of supply for the purpose for which you had occasion to use it? If not, what duration should it have?

We were concerned here with the A-4 bottle. Even though this bottle has already been criticized widely and has been declared inadequate by semi-official sources, we were interested in knowing whether the A-4 bottle is totally unsatisfactory, or whether it might be adequate for certain crew positions, or whether there is any element of faulty training involved.

TABLE XI

Duration of Walk-Around Bottle (A-4). Figures given are percentage of crew members at positions indicated.

POSITION	HAS SUFFICIENT DURATION	INSUFFICIENT DURATION, SHOULD LAST			
		5-8 min.	8-10 min.	10-20 min.	Over 20 min.
Officers	23	6	47	15	6
Top Turret	20	21	44	15	0
Radio Operator	30	15	30	20	5
Ball	26	19	22	15	18
Waist	40	12	36	4	8
Tail	23	17	40	16	4

16. For what purpose did you use the walk-around bottle most frequently?

From the answers to this question, the use of the walk-around bottle is covered in outline form as follows:

I. General uses of walk-around bottle - all members of Crew.

1. Relief
2. Checking crew members when interphone is damaged
3. First aid to injured crew-mate
4. Revival of anoxic crew-mate

II. General uses of walk-around bottle - all gunners.

1. Checking malfunctions at other stations
2. Procedures in bomb bay
    a. Check bomb fuses
    b. Dislodge bombs
    c. Transfer fuel
    d. Crank bomb bay doors
3. Transfer of ammunition to, or procurement of same, from other stations.

III. Specific uses for various gunners:

1. Top Turret
    a. Procedures in bomb bay
    b. Checking plane for damage after attack
2. Radio Operator
    a. Check radio equipment
    b. Transfer ammunition to waist and tail
    c. Help ball turret gunner (see waist gunner)
    d. Procedures in bomb bay
3. Ball Turret
    a. Getting in and out of turret
    b. Reloading of turret
4. Waist Gunners
    a. Helping ball-turret gunner
        (1) Charging ball-turret
        (2) Reloading ball-turret
        (3) Helping turret gunner get in and out of turret
        (4) Wiping turret window
    b. Transfer ammunition to tail
5. Tail Gunners
    a. Procure ammunition from waist

17. Have you ever had gas pains on a combat mission?

Very few men did not have gas pains at least once, and the great majority had such pains on a number of combat flights. The reasons given were "poor chow", "cold sausage for breakfast", "too much spam", "flies contaminated food", "powdered eggs", etc. In other words, the diet was held responsible. However, there were no cases of collapse due to abdominal distension.

18. Have you ever had "bends" pain in the muscles, bones, or joints during a combat mission?

Frankly, the intent of this question was simply to confirm statistically the impression received from the 8AF that decompression symptoms are not a factor in combat operations, so that we would have a basis for minimizing our teaching on this aspect of high altitude flying; for that reason our inquiry was not detailed, as it would have been had we anticipated any significant incidence of aeroembolism. While the findings certainly support the contention that "bends" is not of sufficient importance at present to interfere with operations, there is enough indication in these figures for a more thorough investigation.

TABLE XII

Incidence of bends in combat flights

POSITION	NUMBER OF MEN INTERROGATED	NUMBER REPORTING "BENDS" PAIN	NUMBER OF TIMES "BENDS" PAIN OCCURRED	RANGE OF ALTITUDE
Pilots	19	4	8	18-30,000
Navigators	7	2	2	18-25,000
Top Turret	45	4	6	24-32,000
Radio Operator	31	6	13	18-31,000
Ball Turret	27	7	22	20-33,000
Waist Gunner	52	9	29	20-28,000
Tail Gunner	34	7	10	15-31,000

It should be understood clearly that practically no reliability is placed on the figures as such, because our failure to anticipate occurrence of bends in combat led us to make the inquiry on this point very superficial. Therefore, we do not know (1) whether some or many of the symptoms classed as "bends" pains were due to cold, cramped position, or psychic factors, (2) how many were minor, moderate, or severe, (3) what parts of the body were involved in a number of the cases, and (4) whether the symptoms were sufficient to interfere with duties. Furthermore, because of the limited material, we have no knowledge of the relative incidence in officers as compared to gunners or the trend in incidence in successive flying periods. Nevertheless, a number of pertinent points may be listed, perhaps more as a source of interest than anything else.

a. Many of the men who described symptoms of "bends" pain did not report the incident after returning from the mission because of fear of being grounded. Therefore, more reliable information can probably be obtained in this country than in the zone of operations.

b. A number of the men, when asked concerning the outcome of the "Bends", said they just "sweated it out" because nothing could be done about it since no change in tactics was permitted for the purpose of relieving a crew member of such symptoms. If this can be borne out by further investigation, perhaps more

attention is justified toward preventive measures, particularly for susceptible personnel.

c. The sites of the "bends" included all joints of the extremities, and in one case, the head.

d. One pilot reported that one of his waist-gunners was grounded because of recurrent "bends" over 28,000 ft.

e. One radio operator was instructed by his pilot to administer morphine to a navigator disabled by excruciating pain in both knees at 30,000 ft. The symptoms were ameliorated.

f. Symptoms of "bends", in several cases severe, were described as having occurred in 16 instances in crew-mates; pilots appear to be the most reliable source of information regarding the status of other members of a crew, hence, the urgency of obtaining access to a large number of pilots for interrogations of this type.

g. Even if we assume that all of the instances noted in response to this question were really cases of aeroembolism, the total incidence would only be about one case per 80 sorties; in a high altitude raid of 800 planes, for instance, there would hardly be more than ten men with decompression symptoms - provided that further study yields figures resembling those given here.

19. Please write a detailed account of any incident in which you gave aid to an injured crew-mate, and indicate what equipment you lacked which, if available, would have helped you give the first aid.

TABLE XIII

First Aid at High Altitude

BY WHOM GIVEN	TO WHOM GIVEN	ALTITUDE
Pilots	Top Turret	26,000
Navigators	Bombardier	25,000
	Bombardier	22,000
Top Turret	Bombardier	22,000
	Bombardier	25,000
	Bombardier	28,000
	Waist Gunner	20,000
	Tail Gunner	23,000
	Tail Gunner	20,000
Radio Operator	Ball Turret Gunner	23,000
	Waist Gunner	27,000
	Waist Gunner	25,000
	Tail Gunner	23,000
	Tail Gunner	21,000
	Tail Gunner	23,000
Ball Turret	Radio Gunner	29,000
	Camera Man	22,000
	Waist Gunner	22,000

BY WHOM GIVEN	TO WHOM GIVEN	ALTITUDE
Ball Turret	Tail Gunner	22,000
	Tail Gunner	24,000
Waist Gunner	Radio Operator	22,000
	Radio Operator	24,000
	Radio Operator	22,000
	Bombardier	20,000
	Ball Turret Gunner	24,000
	Ball Turret Gunner	20,000
	Waist Gunner	27,000
Tail Gunner	Navigator	20,000

It is noteworthy that all of the instances were at 20,000 ft. or above, reflecting the necessity for teaching flawless oxygen discipline in combination with first aid, a point omitted from an otherwise excellent training film on "First Aid for Combat Crews." A number of the men were quite voluble in their comments on the importance of a good knowledge of first aid, and in this connection the name of a Major Nowack, Flight Surgeon of a Heavy Bombardment Group in England, was heard more than once in praise for his periodic instruction to his crews on the application of first aid procedures at altitude.

Those who lacked equipment mentioned the following items: (1) More bandages, especially of the larger type, (2) More blankets, and (3) something for cutting away clothing. I formed the impression, in talking to the men, that procurement of such supplies is to a great extent dependent on the initiative of the pilot, except where the flight surgeon made it a matter of his own concern.

Let it also be noted that many of the cases of injury were treated during momentary respite from fighter attack - a circumstance where a knowledge of precisely what to do and the ability to do it quickly has saved and will continue to save lives.

20. From the following list, pick out three procedures which you would consider most important to teach flying personnel in order to train them properly for the conditions they will meet in combat.

There is undoubtedly an arbitrary quality in this approach, and the information obtained would have to be appraised accordingly. With three selections from each individual, there was a total of some 750 selections. The percentage accorded to each procedure was as follows:

PROCEDURE	% SELECTIONS
(1) Have each individual handle the equipment repeatedly during actual high altitude training missions under the supervision of someone with combat experience.	21.9
(2) Have each crew member learn how to give first aid at high altitude.	21.7

(3)	Let each individual find out how it feels to be at high altitude without oxygen.	20.0
(4)	Give detailed lectures on the physics of the atmosphere, the physiology of anoxia, and the symptoms of anoxia.	12.6
(5)	Have each crew member practice revival of anoxic crew mates at high altitude.	9.1
(6)	Have each crew member handle the equipment repeatedly on mock-up installations in the altitude chamber.	7.6
(7)	Teach the prevention and treatment of bends.	4.3
(8)	Demonstrate the difference between free falls and open parachute descent without oxygen.	2.8

A number of errors in the technique of administering the questionnaire detracts from the validity of these figures, but again perhaps the overall trend is significant. It would be of considerable help to have access to enough officers to permit a breakdown of selections from that standpoint, because it is my impression that there is a distinct, although not a critical difference between officers and enlisted men insofar as concerns receptivity to theoretical considerations of altitude physiology and preoccupation with the why's and wherefore's.

21. From your combat experience, will you please indicate what was omitted from your training that should be included, and what was taught in your training that should be stressed more?

Those who volunteered information, under this heading gave the following suggestions as to what should be stressed:

OFFICERS:

(1) Frequent oxygen check of crew members
(2) Conservation of oxygen
(3) Eliminate apprehensions of crew members regarding deleterious effects of altitude on mental processes and on libido or fertility.

GUNNERS:

(1) Frequent oxygen check
(2) Breaking of ice in exhalation ports of demand mask
(3) Proper fit and care of mask

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A SURVEY OF THE MENTAL STATUS OF ALTITUDE CHAMBER TECHNICIANS OF THE ALTITUDE TRAINING UNIT, SANTA ANA ARMY AIR BASE

1. Purpose: It has long seemed evident to the officer personnel of this Unit that if repeated flights in altitude chambers were producing changes of any sort in altitude chamber technicians these changes might very well be so slight and insidious as not to be detected on a routine Form "64" Examination. One of the most apparent stresses imposed upon altitude chamber technicians is that caused by anoxia. Anoxia, or rather hypoxia, is experienced by all inside observers during their 15 minutes stay at 38,000 feet where even a 100% efficient oxygen mask does not completely compensate for altitude; significant hypoxia undoubtedly occurs at lower altitudes also. It has been clearly shown that in animals repeated exposures to anoxia of greater severity than that encountered by altitude chamber technicians does produce definite deterioration in the brain. It follows that one of the most logical places to expect such changes to appear would be in the higher centers of the brain which are so notoriously sensitive to anoxia. The effect of "decompression" per se at high altitudes on the brain is not as well known although neurological symptoms at altitudes above 30,000 feet in trainees are not uncommon. For these reasons it was decided to investigate the mental status of the chamber operators assigned to this Unit.

2. Method: Two methods of investigation were used. The first was an admittedly non-objective approach in which an attempt was made to evaluate the men's reaction to their work and the problems and complaints which this work evoked. The second comprised a purely objective testing of the intellectual resources and abilities of these altitude chamber technicians before and after many hours of repeated chamber flights.

3. Factual Data and Observations:

a. Subjective Investigations: 141 altitude chamber technicians were separately interviewed within a period of three weeks by a medical officer. Chamber time of these men varied from 8 hours to 310 hours with an average time of 110.5 hours. The following points brought out by these interviews are thought to be of interest:

(1) Frequency of "symptoms" during chamber flights: A question which it seemed logical to ask each of the men at the beginning of the interview was, "How often do you have definite symptoms of one sort or another while in the chamber?" Although "chokes" and abdominal pains were included in the answers to this and related questions, these symptoms turned out to be very infrequent, and the great majority of the symptoms experienced were "bends" of varying degrees of severity. With the question in mind as to whether "veterans" were more or less

sensitive to these symptoms than the "new men" in the Unit, the group was arbitrarily divided into those with over 100 hours in the chamber (63 men) and those with less than 100 hours (78 men). Below is a table of the frequency with which the men of the two groups reported themselves to be affected.

	Over 100 hours in chamber (63 men)	Under 100 hours in chamber (78 men)
Almost every flt	15	32
Every 4 or 5 flts	14	22
Seldom	29	15
Never	5	6

From this table it would appear that, subjectively at least, there is a certain amount of "hardening-up" or desensitization in the case of the men with the greater number of chamber hours to their credit. This subjective finding is, of course, subject to many different interpretations.

It is a quite general belief among investigators that the longer a man makes simulated flights, the more sensitive he becomes to the bends. This compilation of subjective data offers rather shallow evidence that such is not necessarily the case. Added to this is the observation made by a great many men of the Unit that while they may ordinarily have no trouble in the chamber, yet if they go on furlough they are very apt, on their return to work, to have moderately severe bends the first one or two times they go up, until they become "re-acclimated" to the work. On the other hand, it has also been observed that some individuals have less symptoms after a period of grounding than they previously had had. It seems reasonable to assume that the manner in which the furlough was spent has some bearing on the matter.

(2) Symptoms following chamber flight: It was felt that a subject worth investigation was whether or not these men experienced any after-effects from a flight. They were, consequently, all asked some such question as "When you come out of the chamber can you tell by the way you feel that you have been up on a flight?" 65 men stated that they felt definitely fatigued after every flight, but it is interesting that of this number 39 noticed the fatigue not immediately but only after a latent period of from 30 minutes to 2 hours. A few of the men stated that they had found this after-effect could be partially or completely aborted by

breathing oxygen for a period after completing the flight. No difference was noted in this respect between the two groups.

(3) Joint pains on the ground: Although in almost no case were joint-pains on the ground sufficiently severe to warrant bringing this complaint to the attention of the medical officer for treatment, nevertheless, when the subject was raised, a surprising number of men (32) stated that they had definitely had symptoms on the ground "almost exactly like bends" except that the pains occurred outside the chamber. The majority of these were grade one or grade two pains, and occurred only in those men who were making frequent flights. An attempt was made to count as significant only those men who had never had any arthritic manifestations previous to coming into the Unit. Nothing objective was ever found; it seemed impossible to tell whether these were physiologically valid pains of a sort never previously experienced, or whether it was simply a matter of their "joint-awareness" having been considerably sharpened by their daily contact with bends. It should be stated that these symptoms were by no means confined to men who might conceivably be suspected of having a psychoneurotic streak, for many of the most stable individuals in the Unit were among those affected.

(4) Memory: Although any significant change in the mental status of these men had been to all intents and purposes ruled out by the Stanine Tests (see Par 3 b, below) the men were nevertheless questioned concerning any change which they might have believed they noticed in their ability to remember names, numbers, etc. Fifteen men made the statement that they thought their memory was appreciably worse than when they started chamber work. One man thought his memory was better. The complaint was equally frequent in the two different groups.

(5) Irritability: The men were also asked whether they felt they were inclined now to be any more irritable than when they had come into the Unit. As might have been anticipated, almost all the men were of the opinion that, immediately following a flight, they were definitely more irritable than normally. But, in addition, there were 24 men who believed their disposition was chronically worse than it had formerly been. Ten of these men were among those who also claimed their memory to be deteriorating. Four men made the unexpected statement that they thought their disposition was better than before.

(6) General problems: Although before the men were interviewed it had been suspected that there was current among them a good deal of vague apprehension about the effects of repeated chamber flights on their health, and "what this is going to do to us 15 years from now," it became apparent with the completion of the interviews that actually the morale of the men was extremely good, and that there was a surprisingly small amount of morbid speculation. The talks did seem to afford a few of the men an opportunity to air some of the problems and questions which were causing concern. Many of these were the simple physiological points

which one might expect: - 1. How many times a week is it safe to go up? 2. Effects of alcohol and tobacco. (It is interesting to note that several of the heavier drinkers among the crew stated that they had less trouble in the chamber after a "rough night" than after a non-alcoholic period--particularly those who were inclined to get the bends, etc.). It was considered that the objective investigations given in Par 3 b, below, were of considerable morale value in proving to the men that the chamber work was doing them no harm.

(7) "Perturbatio sterilitati": A rather unexpected and interesting question was raised by an appreciable number of men concerning the possibility of repeated chamber flights producing sterility. Bearing in mind the work of Van Liere and others on the relationship of sterility to anoxia (work of which, of course, the men had never been informed) an attempt was made to ascertain whether there was any justification in the Unit for the idea. This survey involved the questioning of 55 married altitude chamber technicians as to the pregnancies of their wives. It was found by a little calculation that an average chamber time of 91 hours in 16 cases had in no way impaired sexual and reproductive functions. As was expected in no instance in any of 55 men had there been failure to induce pregnancy when such was desired. It may be noted that by virtue of these interviews the bogey of sterility was ultimately laid.

b. Objective Measurements: The opportunity to investigate objectively the presence or absence of any deterioration of the men's intellectual faculties was presented by the fact that many of these altitude chamber technicians were eliminees from aircrew training and had been tested prior to their elimination by Psychological Processing Unit of this Station.

(1) Stanine Scores: Through the cooperation of the Psychological Research Unit of this Base, 55 altitude chamber technicians who had to their credit a satisfactory number of hours at altitude in the chambers, an average of 140 hours, were given the routine tests for air crew trainees and their stanine scores for pilot, bombardier, and navigator training were compiled. Comparison was made with the stanine scores they had achieved as cadets which were still available in the files of the Psychological Processing Unit. The original and re-examination stanines for the 55 altitude chamber technicians is given in Table I below. It is apparent that a very much improved performance was obtained in almost every case over what had been achieved on the original examination.

TABLE I

Original and Re-examination Stanines of Altitude Chamber Technicians

NAME	CHAMBER HOURS	SCORES ORIGINAL B	N	P	RE-EXAM B	N	P
K. W.	88:30	2	5	1	4	5	4
J. C.	81:13	3	4	2	5	4	4
H. C.	76:00	4	5	4	6	6	6
W. C.	87:21	2	3	1	8	5	4
R. F.	102:56	5	5	7	8	6	7
D. G.	242:19	4	5	6	7	5	6
C. G.	137:45	2	1	1	4	3	3
D. H.	103:12	9	7	8	9	9	9
L. H.	110:40	3	6	4	6	5	5
C. K.	104:37	1	3	2	6	4	4
W. L.	96:32	9	9	8	9	9	9
W. M.	105:32	5	5	3	7	6	6
F. M.	198:40	7	7	6	9	9	8
C. M.	89:24	3	4	4	5	5	5
R. S.	83:20	7	6	5	9	8	9
F. Y.	73:05	3	5	2	6	6	5
H. S.	186:33	3	3	2	7	4	2
H. S.	175:37	4	5	5	9	6	7
C. W.	30:04	9	8	9	9	9	7
T. M.	143:19	1	1	1	4	2	1
H. B.	175:52	1	3	2	4	5	4
J. C.	118:59	2	3	2	4	4	4
J. R.	105:48	2	3	2	3	4	2
J. C.	134:56	6	6	3	9	7	5
F. D.	150:35	2	2	2	3	3	3
E. L.	174:53	2	1	2	6	4	6
H. W.	203:12	4	4	3	8	7	5
D. M.	148:46	1	2	1	6	4	1
G. W.	163:48	4	3	5	9	7	7
P. M.	148:00	5	3	6 + 3	9	6	8
E. M.	221:28	6	6	7	9	9	9
J. R.	208:33	1	5	3	8	5	7
D. M.	195:38	6	7	6	9	8	7
C. C.	148:37	4	4	6	9	6	7
D. S.	162:54	4	6	5	8	7	6
C. P.	91:13	8	7	6	6	5	8
P. M.	93:52	4	4	3	7	5	3
J. H.	59:41	6	2	7	9	5	9
J. C.	199:12	1	1	1	1	1	1
J. E.	183:39	3	2	3	7	2	5
C. J.	192:36	2	3	2	6	5	7
L. T.	156:19	5	6	3	9	7	6
H. F.	114:49	4	1	5	6	4	4
A. G.	184:44	4	1	4	7	6	4
L. K.	65:14	1	2	3	5	4	6
G. S.	220:19	4	6	5	3	5	2
C. L.	218:42	4	4	4	8	7	6
D. Z.	168:55	4	3	5	9	6	7
C. Z.	132:32	5	5	3	9	7	4
T. H.	91:47	2	4	1	8	4	3
R. C.	114:47	3	1	3	4	3	5
J. O.	174:03	2	4	2	6	4	6
P. R.	156:38	7	7	6	8	7	9
J. S.	150:07	5	5	4	7	6	9
T. V.	200:27	4	4	2	6	5	4
55 cases	Ave = 140:	Ave = $\bar{3}$	$\bar{4}$	$\bar{4}$	$\bar{7}$	$\bar{7}$	$\bar{5}$.49 5.49

(2) More Valid Tests of Mental Function: The fact that so much improvement was found in the stanine scores of the altitude chamber technicians over what had been their original accomplishment indicated that a learning factor was playing a very important part in the scores. Accordingly, the Psychological Research Unit was asked to determine whether there was any portion of the nine-hour examination which might be considered to be relatively free of any learning component and of which the results could be evaluated independently of the remainder of the test. It was their opinion that only two tests would be satisfactory from this point of view. These two tests were Mathematics "B" and "Reading Comprehension." Analysis was then made of the scores which the men achieved on these two sub-tests, both on the original examinations and on the re-examination, and a comparison made. The report which the Psychological Research Unit submitted on this analysis is appended. It may be summarized by the statement that although the group tested is too small to be statistically free of criticism there is still every indication that the men studied had suffered no mental deterioration and had, in fact, shown some small improvement.

4. Summary:

a. Investigation of the mental status and intellectual functions of altitude chamber technicians was carried out utilizing both subjective and objective approaches.

b. There was no evidence of any mental deterioration and indeed there was some evidence of increased intellectual capacity.

c. This investigation is considered not only of scientific value but also to have been of considerable benefit to the morale of the altitude chamber technicians of this Unit.

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Appendix 1

PSYCHOLOGICAL RESEARCH UNIT #3
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TEST-RETEST STUDY OF READING COMPREHENSION AND MATHEMATICS B MADE ON A SAMPLE OF ENLISTED MEN OF THE 33RD ALTITUDE TRAINING UNIT

A sample of forty-nine enlisted men of the 33rd Altitude Training Unit was available for test-retest investigations of Mathematics B and Reading Comprehension. The lapse between test and retest varied from six months to a year and a half.

Certain men were tested during the period when the scores were in standard deviation units. The means for unclassified cadets on these tests were 5.00. The means for this sample were 4.39 for Reading Comprehension, and 4.26 for Mathematics B (see Ia and IIa, Table I below). The mean in raw score units of those men who were first tested more recently were 20.36 for Reading Comprehension and 11.45 for Mathematics B (see Ic and IIc, Table I below). The means for unclassified cadets for these tests were 20.45 and 14.87 respectively.

TABLE I

Test-retest Data for Reading Comprehension and Mathematics B

	Test		Retest	Unselected Cadets
I. Read. Comp.	a. stand. M = 4.39	N = 38	-	5.00
	b. $*\frac{x}{\sigma} = -.305$		-	
	c. raw M = 20.36	N = 11	raw M = 20.55 N = 49	20.45
	d. $\frac{x}{\sigma} = -.01$		$\frac{x}{\sigma} = +.01$	
II. Math B.	a. stand M = 4.26	N = 38	-	5.00
	b. $\frac{x}{\sigma} = -.37$		-	
	c. raw M = 11.45	N = 11	raw M = 12.80 N = 38	14.87
	d. $\frac{x}{\sigma} = -.37$		$\frac{x}{\sigma} = -.225$	

* $\frac{x}{\sigma}$ = difference between sample mean and mean of unclassified cadets divided by the standard deviation of unclassified cadets.

5-3969,AF

Conclusion

First it should be noted that the sample used in this test - retest study (49 men) is of such a small nature as to affect the actual reliability of the study. Nevertheless, some indications may be noted. From the observed figures the mean of the retest scores rise. However from previous test - retest data on these same tests we find approximately the same degree of mean improvement from test to retest. Therefore it is safe to assume that there is no evidence for any change in ability level of the 49 men retested on Reading Comprehension and Math. B caused by their prolonged exposure to partial anoxia.

* * * *

THE PREVENTION OF AERO-OTITIS MEDIA IN THE ALTITUDE CHAMBER

Aero-otitis media occurring in the altitude chamber flights is by no means a small problem, for the incidence ranges from eleven to seventeen percent and, if the individual subject who develops the Eustachian tube blockage is on flying status, he must be grounded until recovery takes place. Four methods are at present employed to decrease the incidence or lessen the severity of aero-otitis media. These are: 1) the elimination of passengers with severe colds before each flight; 2) the elimination of each passenger who develops ear trouble on a preliminary 5,000 ft. run; 3) the use of a controlled and constant scale of descent; and 4) "leveling off" and "bouncing" the chamber when any passenger develops symptoms of aero-otitis media. The first of these measures is unquestionably justified. The weeding-out process of the preliminary run eliminates about forty percent of the total number of cases of aero-otitis media, and while it increases the total incidence, it also prevents the occurrence of severe Eustachian tube blockage in this eliminated group. Reasonably slow descent on a standard pressure scale has reduced the aero-otitis media incidence from about twenty percent to its present level and has diminished the degree of the resulting blockage. Relief from subjective discomfort by reascent in the chamber is almost instantaneous in each case but this procedure usually has to be repeated when descent is resumed, and evidence of aero-otitis media is frequently present when the flight is completed. Ground level inflation of the middle ears with continuous pressure Politzerization has produced satisfactory relief and possibly speeded up the recovery in such cases (See Air Surgeon's Bulletin, 1:18 (Apr) 1944).

With this in mind, it was decided that a continuous pressure inflation mechanism used during descent in the chamber might prevent the production of true aero-otitis media with its so-called secondary changes; i.e., edema, serious otitis media, and petechial hemorrhage. Another advantage which might be derived would be

the elimination of the loss of time which resulted from "leveling off," "bouncing" the chamber, and the very slow subsequent descent.

The principle of Politzerization is based on the fact that when one swallows, the soft palate is momentarily drawn upward and converts the nasal and nasopharyngeal cavities into a space which is open only at the nares. If, at this instant, a flow of air is introduced through one nostril and the other nostril is occluded, a positive pressure will be developed in this closed cavity and will, with the aid of the muscles of swallowing, force its way up the Eustachian tubes. The advantage gained by the use of continuous pressure is that the patient can swallow at any time he chooses and inflate his ears.

In order to obtain this effect in the chamber, a simple cross-joint was mounted on a board (see drawing) and the four outlets were connected to: 1) a mercury manometer; 2) a nasal tip; 3) an adapter passing through the chamber wall; and 4) a constant leak exhaust valve. A screw valve for pressure control was inserted in the metal line connecting with the outside pressure and a gross scale was drawn in beside the mercury column. Simple directions were typed out and posted on the board (Chart I). The use of green, yellow, and red blocks opposite the manometer denoted safe, cautious, and dangerous pressure levels. A catch trap was placed so that it would receive the mercury if the omnipresent venturesome individual tried to use excessive pressure. The mercury can be easily replaced in the manometer but the manipulation required should make the operator think twice before he attempts to exceed the recommended force again.*

The pressure levels advised are based on the experience gained in the Politzerization of well over five hundred (500) cases of aero-otitis media. One hundred millimeters of mercury seem to be the upper limit of conservative safety, and pressures well below this are usually effective. The greatest pressure which this inflation manometer permits is about one hundred fifty millimeters of mercury.

This prophylactic method cannot be used with ease on subjects above the critical oxygen level though the presence of an observer in the chamber minimizes the danger. In descent from a long flight at 38,000 ft. there is presumed to be a cumulative anoxia. Consequently 15,000 ft. instead of 18,000 ft. has been adopted as the level below which the mask may be removed, for a period of time, with comparative safety. The inflation manometer pressures become inadequate below 1,500 ft. It should be borne in mind that one inflation during descent is the exception rather than the rule, for most sufferers from inadequate middle ear

*After the instrument had been installed and was being tested, it was learned that Navy personnel had devised a somewhat similar apparatus.

ventilation will need repeated assistance in clearing their ears. For these reasons it is desirable that an individual who must use the inflator during descent repeat the inflation at least every 2,000 ft. and obtain the final inflation just about a level of 1,500 ft.

This method of inflation of the middle ears has been in use in several of the altitude chambers throughout the country and the only difficulties reported have been due to the rubber tubing originally used in the pressure source line and in the adjustable exhaust valve. The replacement of the rubber tubing with oxygen tubing and of the adjustable valve with a constant flow (1/16 - 1/32 inch) opening has apparently overcome these difficulties.

A simple adjunct which frequently determines the success of inflation is the taking of a sip of water just before the Politzerization is attempted. A container of water kept in the altitude chamber will be found useful.

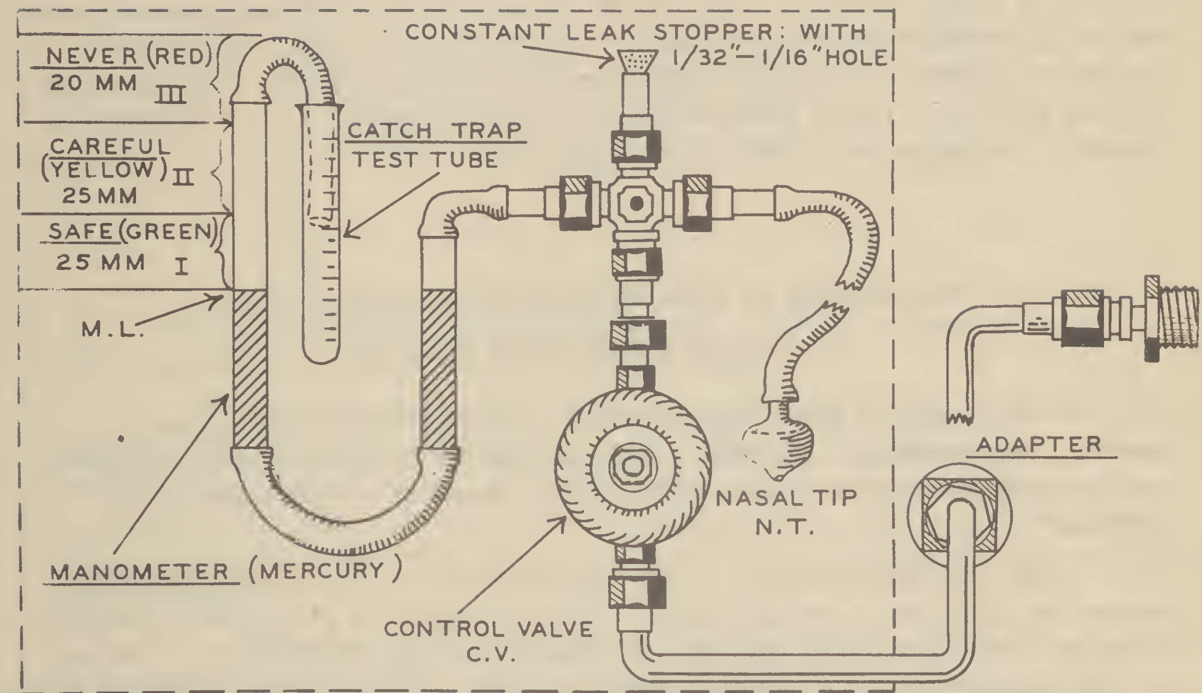
CHART I

Directions for Use

1. Close nasal tip (N.T.) by placing the finger over the opening.
2. Open control valve (C.V.) slowly until the mercury level (M.L.) is opposite the upper part of the green box (I).
3. Place the nasal tip (N.T.) in one side of the nose and make it fit snugly.
4. Block the other side of the nose with finger pressure and swallow, while holding the head erect.
5. If no pressure is felt in the blocked ear, repeat Steps 1 and 2, setting the mercury level (M.L.) opposite some part of the yellow box (II): now repeat Steps 3 and 4.
6. If swallowing is difficult take a sip of water just before inflation is tried.
7. The inflation of one ear may be aided by laying the head on the opposite shoulder without tucking the chin down.

Never raise mercury level (M.L.) to place opposite red box (III).

Never fail to close control valve (C.V.) after descent is completed.



INFLATION MANOMETER
(FOR USE IN ALTITUDE CHAMBER)

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EDITORIAL NOTE: In a recent communication to the Office of The Air Surgeon, Major George C. Saunders, MC, Surgeon, McChord Field, Washington, reported an interesting observation relating to the relief of aero-otitis. About a year ago Major Saunders, after having recently recovered from an acute head cold, was flying from Alaska to the United States. Upon landing for refueling both ears became stuffy and uncomfortable. A few minutes later he was forced to run, clad in heavy flying clothes, from the hangar to the plane. A moment after sitting down,

breathless, in the plane his eustachian tubes suddenly opened. Major Saunders concluded that "sudden circulatory change caused by exercise had caused a depletion of the boggy tissue surrounding the eustachian tube with resultant restoration of its function. Later while at Hamilton Field, Major Saunders found that pilots completing altitude chamber flights with mild tubal obstruction frequently obtained relief after running twice around the block. Other altitude training units may find it worth while to test the adequacy of this procedure as a means of relieving mild cases of aero-otitis.

*　　　*　　　*　　　*

THE INFLUENCE OF PREVIOUS HISTORIES OF SINUSITIS AND OF COLDS ON DECOMPRESSION SINUSITIS

Two questions about aerosinusitis, as experienced in decompression chambers, were examined: (1) does a previous history of sinus trouble increase its incidence? and (2) does the simultaneous presence of a cold increase its incidence?

The test used was that of the Type 2 Flight of the Altitude Training Program, WD Directive of 17 July 1943. This consisted of a 25 minute ascent to 30,000 ft., 60 minutes at 30,000 ft., and then 15 minutes at 38,000 ft. Descent was then accomplished at a pressure change of 27 mm. Hg per minute, sometimes with pauses to facilitate "clearing" of the ears. Before this main flight, an ascent to 5,000 ft. above ground level was made; if on this preliminary flight, a man could not clear his ears, he was not allowed to go on the main flight.

Student gunners receiving their altitude training at this base (altitude 3435 ft.) were used as subjects. Each man kept a record of his flight, noting whether he had sinus pain during flight, whether he had a cold, whether he had ever had sinus trouble, and if so "how long ago", i.e. the date of his most recent attack. No attempt was made to determine the severity of the sinusitis, present or past, or the severity of the reported colds. The data were collected on 3055 man flights between 7 February 1944 and 26 April 1944.

RESULTS

1. Sinus history in relation to aerosinusitis

It was found that a group of men with a previous history of sinusitis were far more susceptible to aerosinusitis than a group of men without previous sinus history. Table I shows the results obtained.

TABLE I. Sinus history in relation to aerosinusitis

Group	Number of Cases
No aerosinusitis or sinus history	2743
Aerosinusitis but no sinus history	35
Aerosinusitis with sinus history	59
Sinus history but no aerosinusitis	218
Total	3055

From the table it is evident that of those decompressed (3055 men), aerosinusitis developed in 3.1% (94 men). Also, a history of sinusitis was reported by 9.1% (277 men) of this same group.

Of the group of 277 men with a history of sinusitis, 21.3% (59 men) experienced sinus pain in the decompression chambers. Of the group of 2778 men without sinus history, only 1.3% (35 men) experienced aerosinusitis. The two percentages, 21.3 and 1.3, are in the proportion 16 to 1, indicating that men <u>with</u> sinus history are 16 times more susceptible to aerosinusitis than men <u>without</u> sinus history.

This is not to imply that all men who experienced sinus pain in the chamber had a previous history of sinusitis; in fact, out of 94 men who experienced aerosinusitis, 37% (35 men) had no previous sinus history.*

2. <u>Date of sinus history in relation to aerosinusitis</u>

The date of sinus history was found to be related, within limits, to the incidence of aerosinusitis, as shown in Table II.

TABLE II. Date of sinus history in relation to aerosinusitis

Time since last sinus attack	No. Reporting aerosinusitis	No. Reporting no aerosinusitis	Total reporting sinus history	% with aerosinusitis	
"Now"	19	18	37	51	
0-6 mos.	7	41	48	15	
7-12 mos.	1	8	9	11	
1 yr.	6	32	38	16	Ave. 12.5
2 yrs.	4	31	35	11	
3-4 yrs.	4	37	41	10	
5-6 yrs.	1	21	22	5	
Over 7 yrs.	5	26	31	16	
Unknown	12	4	16	--	
Totals	59	218	277		

*All of these figures are submitted to statistical analysis in the Appendix, <u>c.v.</u> Also, the case discussed in this paragraph (correlation between aerosinusitis and sinus history), as well as other correlations, are fully considered there.

Of the group of 37 men reporting they had a history of sinus trouble "now", i.e. present and probably chronic, 51% (19 men) experienced sinus pain in the chamber. Of the group of 224 men reporting sinus attacks a few weeks to many years previously, 12.5% (28 men) experienced aerosinusitis. In substance, whether the reported history was recent or old, always about the same percentage experienced pain in the chamber, i.e. about 12.5%. This is about one-quarter the incidence observed in those with present and chronic history. In contrast with these two figures, 1.3% (see above) of those without previous sinus history experienced aerosinusitis, i.e. about one-fortieth the incidence of those with present and chronic sinusitis.

3. Aerosinusitis in relation to colds

The presence of colds was related to aerosinusitis, as shown in Table III.

TABLE III. Aerosinusitis in relation to colds

Group	With cold	Without cold
No aerosinusitis or sinus history	710	2033
Aerosinusitis but no sinus history	13	22
Aerosinusitis with sinus history	16	43
Sinus history but no aerosinusitis	66	152
Totals	805	2250

Colds were reported in 805 of 3055 man flights -- an incidence of 26.4%. Of the 805 men reporting colds, 3.6% (29 men) experienced sinus pain in the chamber; of the 2250 men without colds, 2.9% (65 men) experienced sinus pain in the chamber.* In other words, our group without colds was found as susceptible to aerosinusitis as our group with colds. This unexpected result is perhaps due to a preselection of flight subjects: at this unit, men are not decompressed who cannot "clear" their ears on a short preliminary "flight" 5,000 ft. above ground level. In this group there are many men with severe colds who would presumably have experienced such sinus trouble.

Even in those with a previous history of sinusitis, colds did not significantly affect the incidence of aerosinusitis. Of those reporting sinus history with a cold, 20% (16 out of 82 men) experienced sinus pain in the chamber; of those reporting sinus history without a cold, 22% (43 out of 195 men) experienced aerosinusitis.

*The difference between 3.6% and 2.9% is not statistically significant: chi square equals 1.031. See Appendix.

Summary

In 3055 man flights to 38,000 feet in decompression chambers, it was found that:

1. Men with sinus history were 16 times more susceptible to aerosinusitis than men without previous sinus history;

2. Men with chronic and present sinus trouble were 40 times more susceptible to aerosinusitis than men without sinus history and 4 times more susceptible than men with an old sinus history; and

3. In our selected group of men, colds did not predispose to aerosinusitis, whether or not they had reported a previous history of sinusitis.

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Comment by the Office of The Surgeon, AAF Training Command: "Reference paragraph 3 of Summary, it is obvious that exclusion of individuals with current nasopharyngitis, and the treatment by nasopharyngeal spray of all individuals within clinical limits acceptable for a flight, would render comparisons as to the predisposing effect of colds relatively pointless. In the experience of observers who have made similar studies, recent or current nasopharyngitis almost inevitably predisposes an individual to aerosinusitis."

APPENDIX

The data of Tables I, II, & III in the text will be recast the familiar 4-cell form for ease of comprehension.

TABLE I. Sinus history in relation to aerosinusitis

	History	No History	Totals
Aerosinusitis	59	35	94
No Aerosinusitis	218	2743	2961
Totals	277	2778	3055

If there were NO significant relation between aerosinusitis and its previous history then we would expect that through chance the following theoretical distribution would most likely occur:

	History	No History
Aerosinusitis	8.5	85.5
No Aerosinusitis	268.5	2692.0

$$\chi^2 = \sum \frac{(f_0 - f)^2}{f},$$

f = Theoretical, expected frequency

f_0 = Observed frequency

$$\chi^2 = 330.72$$

The magnitude of chi square being a measure of the difference between observed and expected frequencies, allows us to judge whether or not these differences can be attributed to chance sampling errors. Thus, if $f_0 = f$, chi square equals zero; therefore the original hypothesis of no relationship is justified. But the greater the disparity between f_0 and f the greater the value of chi square becomes, and if it exceeds a certain limit we can conclude that the hypothesis is false; i.e. a relationship does exist between aerosinusitis and a previous history. If we select .01 as the fiducial limit of probability, chi square must exceed 11.34 before we can accept the probable existence of this relationship. Conversely if chi square is less than 11.34, no relationship is demonstrated. The value of 330.72 calculated for the above Table I is therefore indicative of a significant relationship between aerosinusitis and a previous history.

The inverse case has the same statistical significance:

Of 94 with aerosinusitis, 63% had previous history;

Of 2961 without aerosinusitis, 7.4% had previous history.

$$\chi^2 = 330.72;\ \text{significant}$$

TABLE II. Date of sinus history in relation to aerosinusitis

	Aero-sinusitis	No Aero-sinusitis	Totals
Sinus "Now"	19	18	37
Sinus "Before"	28	196	224
Totals	47	214	261

$$\chi^2 = 32.18;$$

that is, the differences between observed and expected frequencies are greater than what might be obtained by chance, and therefore the relationship of dates to aerosinusitis is considered to be significant.

Table III of the text is analyzed in two ways: A, to see what over-all relation exists between aerosinusitis and colds; and B, to see what special relation exists between aerosinusitis and colds in those subjects reporting a previous history of sinusitis.

TABLE IIIA. Aerosinusitis in relation to colds

	Colds	No Colds	Totals
Aerosinusitis	29	65	94
No Aerosinusitis	776	2185	2961
Totals	805	2250	3055

$$\chi^2 = 1.031;$$

that is, the differences between expected and observed frequencies can be attributed to chance and are therefore not significant.

TABLE IIIB. Aerosinusitis in relation to colds for those with previous history of sinusitis

	Colds	No Colds	Totals
Aerosinusitis	29	65	94
No Aerosinusitis	776	2185	2961
Totals	805	2250	3055

$$\chi^2 = 0.233;$$

differences not significant.

Other miscellaneous relations which can be derived from inverse cases involving colds are as follows:

1. Consider only the 805 men who had colds:
   Of 29 with aerosinusitis, 55% had previous sinus history.
   Of 776 without aerosinusitis, 8.5% had previous sinus history.
   $$\chi^2 = 66.08; \text{ significant.}$$
2. Consider only the 94 men who experienced aerosinusitis:
   Of 29 having colds, 55% had previous sinus history.
   Of 65 not having colds, 66% had previous sinus history.
   $$\chi^2 = 1.033; \text{ not significant.}$$

3. Consider only the 2778 men without history of sinusitis;
   Of 723 having colds, 1.8% experienced aerosinusitis.
   Of 2055 not having colds, 1.1% experienced aerosinusitis.
   $\chi^2 = 2.287$; not significant.

4. Consider only the 277 men with history of previous sinusitis;
   Of 82 having a cold, 19.5% experienced aerosinusitis.
   Of 195 not having a cold, 22.0% experienced aerosinusitis.
   $\chi^2 = 0.233$; not significant.

A comparison of relations 3 and 4 shows that a previous history of sinusitis predisposes to aerosinusitis, but that presence or absence of colds in either case is not significant. This same over-all conclusion was reached in Section 3 of the text, where reasons to account for the situation are advanced.

* * * *

DIGEST OF USEFUL DEVICES FOR ALTITUDE CHAMBERS

1. Position of chamber valves.
2. Artifical Altimeter.
3. Altigraph.
4. Air flow indicator.
5. Thermometers wet and dry.
6. HS 33 or 38 headsets and adapters, and teletalk extension.
7. Film strip projector.
8. Gunnery trainer.
9. Altitude warning signal.
10. Oxygen supply alarm.
11. Chamber refrigeration.
12. Illumination control.

In order to reduce operating personnel for the Altitude Chamber, the repositioning of chamber valves from the side window to one of the end windows on chambers which have control valves on the side, can be readily accomplished by the post engineers. This work can be done with little or no extra pipe, and results in a saving of one man in operating personnel.

The connection of the chamber altimeter so that it may be manually controlled from the outside can easily be accomplished by reference to Fig. 1.

Essentially there are three control valves: (a) for suction, tapped into the main chamber suction line; (b) for air at atmospheric pressure; (c) to connect altimeter back to normal operation. Oxygen line shut-off valves (AC Stock No. 5500-959360) can be used as control valves. The only other material required is some aluminum tubing and other ordinary oxygen fittings. On the air inlet it will be found advantageous to reduce the size of the inlet orifice by connecting it to a piece of partially occluded aluminum tubing. This will effect greater senstitivity of control.

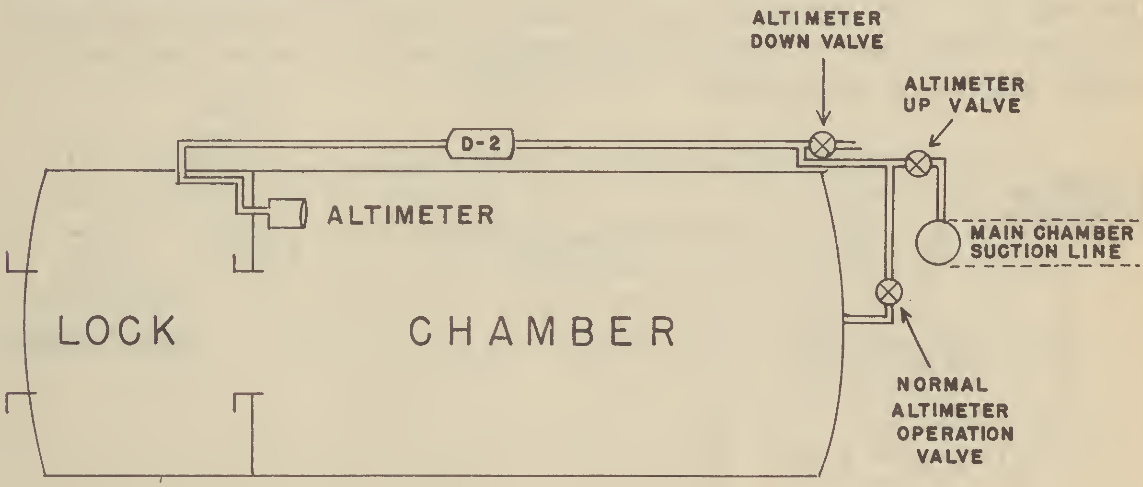

fig. 1

The altigraph (AC Stock No. 6000-007600 - Class No. 05c) is a device which can be of considerable use to an altitude unit in that it will record on paper practically all the data which a run may require, thus eliminating another man from the chamber operating crew. The paper on which the instrument writes is calibrated in inches Hg but altitude can be read directly by overprinting on the paper altitude in feet. The necessary records of the run exclusive of altitude changes can be taken care of by the lock operator. This makes it feasible to operate the chamber with a working crew of 5 men; (1) chamber operator, (2) chamber observer and lecturer, (3) inside observer, (4) lock observer, (5) lock operator.

It is frequently desirable to know how much ventilation is being supplied to the chamber, this is especially important when anoxia demonstrations take place since the amount of oxygen in the air can be excessive if suitable

ventilation is not supplied. A simple means of measuring ventilation is by using an air speed indicator (AC Stock No. 6000-176790). (This is a relatively obsolete instrument and hence does not create a shortage in combat-type instruments). The static or suction side of the indicator is connected to an aluminum tube which runs about 1 inch inside of the air intake pipe. In case a maxim silencer is used on the chamber air intake pipe, it is necessary to connect a 2" piece of pipe to the top of the intake silencer because inside the silencer the airflow is not smooth and therefore not as much suction is created. (See Fig. 2). Since air moves into the chamber because of the pressure gradient along the intake pipe, by measuring this gradient near the intake a measure of chamber ventilation is obtained.

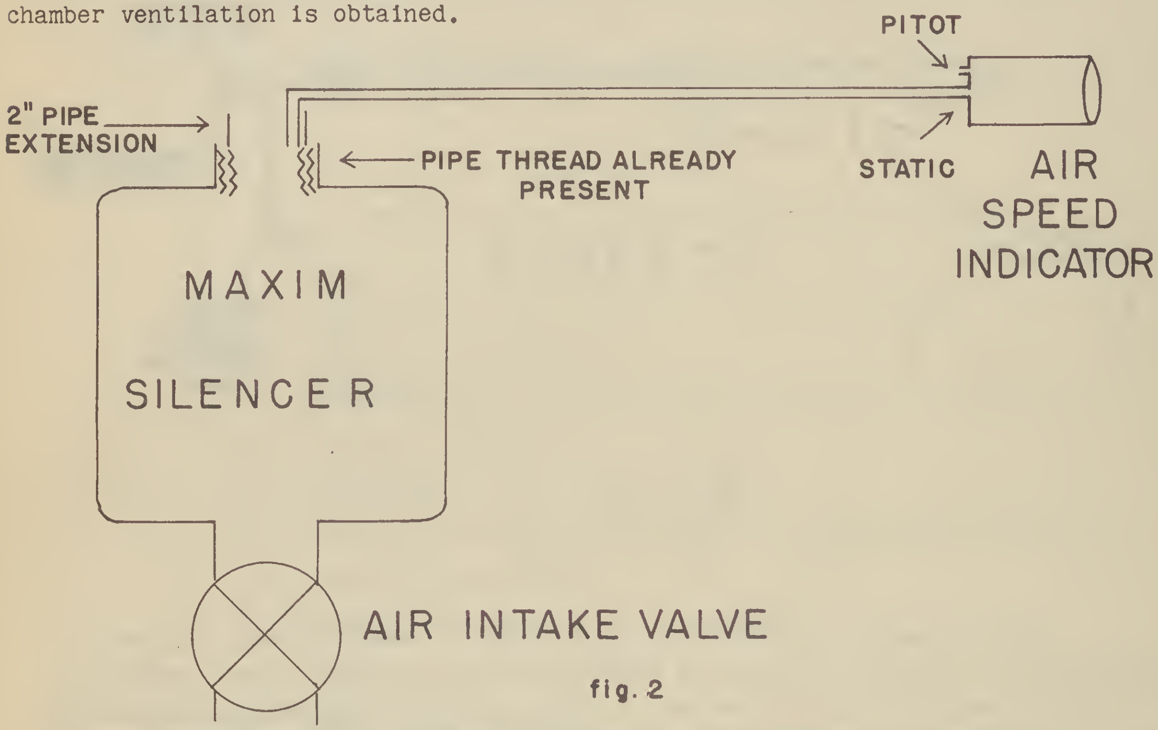

fig. 2

Since one of the reasons for supplying ventilation is to afford more passenger comfort by reducing both temperature and relative humidity, a further aid to proper operation is given by the installation of wet and dry thermometers where they can be read and also where they will be assured a representative airflow. The best position for the thermometers is near the exhaust connection inside the chamber. Glass bulb thermometers cannot be read from this position with any ease, however, so that electric free air temperature thermometers, as used on airplanes, were installed. These indicators (AC Stock No. 6600-257110) can be mounted on a panel, and the bulbs (AC Stock No. 6000-036522) mounted very close to the air exhaust. One bulb has a wick covering it and a tube of water is nearby (See Fig. 3). Also see T.O. 05-40B-1.

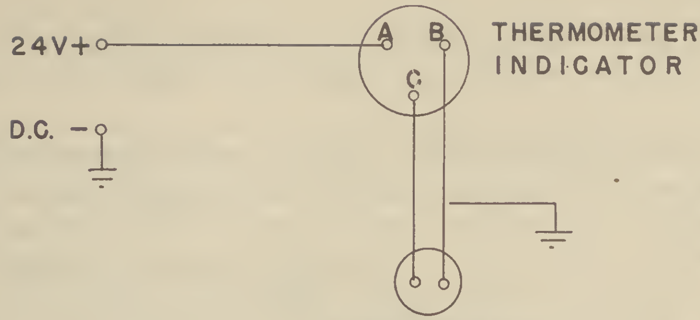

fig. 3

In the event that altitude chamber has an interphone system installed, attention is invited to the fact that headsets are now available, both with and without headband, which have a markedly superior fidelity to voice reproduction as compared with the old type magnetic headsets. The new headsets (HS33 or HS38) are distinguished by having a red plastic plug instead of a black one and must be used with an adapter (4A985A), Stock No. MC-395-A, which plugs into the interphone box. Attention is further invited to the fact that the teletalk system, usually supplied with the altitude chamber, can be connected to the "phone" plug of an interphone box and the interphone conversations and lectures can be monitored at a distance from the chamber.

One of the major problems in training runs is preserving interest throughout the entire indoctrination run, this is especially difficult during the final descent. By using a film strip projector (AC Stock No. 8900-679400, Class 10-B) with film strip No. FS-1-739, or any film strips made locally, (the base photo lab can usually copy posters and items of equipment for 35 mm film strips) and using an ordinary window shade for a screen, the time during descent can profitably be used for instruction.

The use of the E-8 Spot-O-Lite gunnery trainer in altitude training is described elsewhere (ATU Memorandum report) in detail. It has been found unusually effective in demonstrating the effect of slight degrees of oxygen lack on performance.

The altitude warning signal (AC Stock No. 6000-340000) is a standard item on the B-29 and is used to operate a horn when the cabin altitude goes above 10,000 feet. This device can be installed in the chamber and connected to a horn (AC Stock No. 4240-39606, Class 03-C) through a single pole switch. In the indoctrination of B-29 crews this device is useful in training the men to recognize the signal as the time to start using oxygen pending the return of cabin

altitude to below 10,000 feet. The value of this device in training air crews in explosive decompression or uncompensated cabin pressure leaks is considered to be important. T.O. AN 05-1-40 will give detailed directions for wiring and installation.

A safety feature which will warn that the chamber oxygen supply is about to give out can easily be constructed from the following parts: (1) oxygen pressure signal assembly. (AC Stock No. 5300-786500), (2) a signal bell (AC Stock No. 4248-5029-A, Class 03-C). A single pole switch is used to turn the system on and off and the pressure signal assembly is adjusted to go off at 200 p.s.i. instead of its normal 100 p.s.i. value. At this pressure, several minutes are available for turning on a new supply before total failure of oxygen supply occurs. (Diagram see Fig. 4).

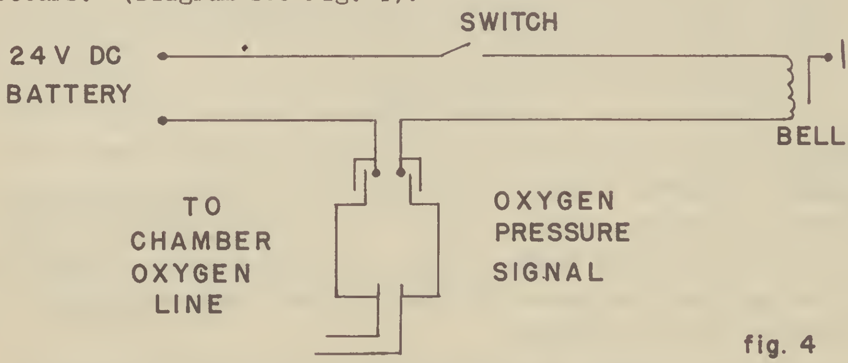

fig. 4

Regardless of any reasonable amount of ventilation supplied, descents in the altitude chamber with a full complement of trainees will be rather uncomfortable because of the air compression effect a warm room, and the use of various types of high wattage projection lamps and other electrical equipment. In locations where building air conditioning is unfeasible or impossible to procure, a small (1 or 1½ HP compressor) unit with a radiator and small blower (similar to that in an ordinary home electric refrigerator) installed inside the chamber under a seat will answer the problem of cooling. In this unit's present installation the building is cooled with a standard 5 HP unit but additional cooling is felt desirable the year round when the building unit would not be operating.

For visual acuity demonstrations with anoxia test cards, low intensity uniform illumination is essential for convincing results. This cannot be achieved using the fluorescent system of the chamber. Several schemes have been proposed by other units and by Wright Field. The following system was used only because the parts were readily available. A transformer originally used on an oxygen system mockup board to light the signal lamp was removed and replaced with a 22½ volt "C" battery and a switch. This transformer gave 12, 16, 20, and 24 volts AC

and ran on 110V AC, taps were made on these various voltages and connected through a rotary switch to a set of 24V bulbs (as used in oxygen warning signal lights), the sockets were standard warning signal light sockets and these were soldered onto a long sheet metal pan one about every ten inches; there was one pan for each side of the chamber and these were fastened to the sides of the fluorescent lighting fixtures. With a light green painted interior, measurements gave the following illumination: 24V-1, 16V-½, 12V-¼ ft. candle. (Diagram of set-up see Fig. 5).

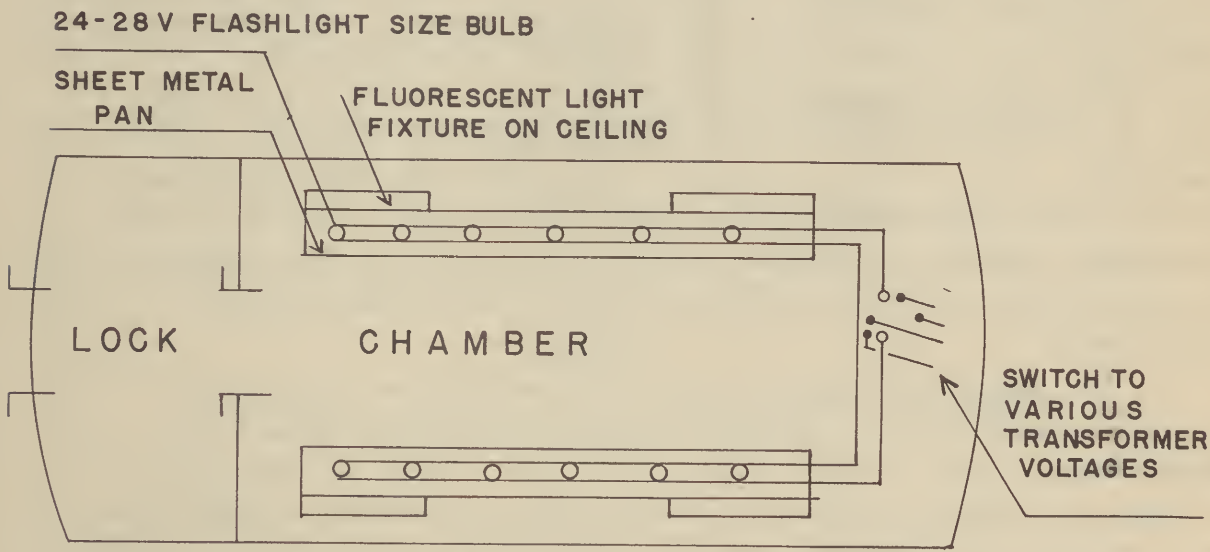

fig. 5

Staff, Altitude Training Unit
Smoky Hill Army Air Field
Salina, Kansas

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The Effects of Anoxia on Gunnery Scores

1. <u>Introduction</u>: In order to make anoxia demonstrations in combat crew training more effective, an attempt was made to relate one of the demonstrations to actual duties in the air. For this purpose gunnery apparatus was installed in the decompression chamber and experiments were conducted to devise a procedure which would produce a clear-cut performance decrement with lack of oxygen. The present report describes:

a. Gunnery training equipment which can be used to demonstrate anoxia.

b. The results of anoxia at 22,000 ft pressure altitude on the shooting ability of gunners.

2. Apparatus: The Aerial Gunnery Trainer, Type E-8, is used. This trainer consists of a moving projector, which throws a spot of light following an eccentric pattern determined by relays, and a recording apparatus which registers both shots and hits on Veeder-Root counters. The recorder is mounted to the under side of the chamber bench. Numerous types of guns and gunsights can be used with this equipment. A photo-electric cell connected to the sighting apparatus registers hits made on the moving target. In the present study a Left Blister Sighting Station as installed in B-29 airplane is used. This station can be quickly attached to a support welded to the chamber wall. The projector is mounted on a movable base which can be placed on the chamber floor. For a screen, a thirty-six inch window shade is mounted at one end of the chamber just inside the door leading to the lock. The screen is nine and one-half feet from the projector and seven feet from the sighting station. The photo-electric cell amplifier and main amplifier are located under the chamber bench.

3. Method: The angle of sweep of the projector is restricted to the smallest possible values (azimuth 45 degrees and zenith 30 degrees), and the speed control set on "high." With such an angle of sweep the target spot will move off the target frequently. However, the target cannot be hit when off the screen, and the above method proves quite satisfactory for obtaining reliable scores. After experimenting with various altitudes and combinations of trials the following procedure was found to be the most satisfactory:

a. Chamber is taken to pressure altitude of 22,000 feet.

b. To obtain a relatively constant level of performance, each subject receives the following practice with oxygen:

(1) One-half minute of tracking without shooting.

(2) Three shooting trials of two minutes duration each. (In previous testing two practice trials were used, but this was found not as satisfactory as three. Results will be reported on subjects with two as well as three preliminary trials since combining the groups will not give an exaggerated picture of the decrement produced by anoxia).

c. Subject is then unplugged and allowed to sit for thirty seconds to develop slight anoxia. This is followed by a series of two-minute

trials without oxygen. Trials are ended by turning off the projector light. Only enough time is allowed to elapse between trials to record hits and shots and to reset the counters (usually about fifteen seconds).

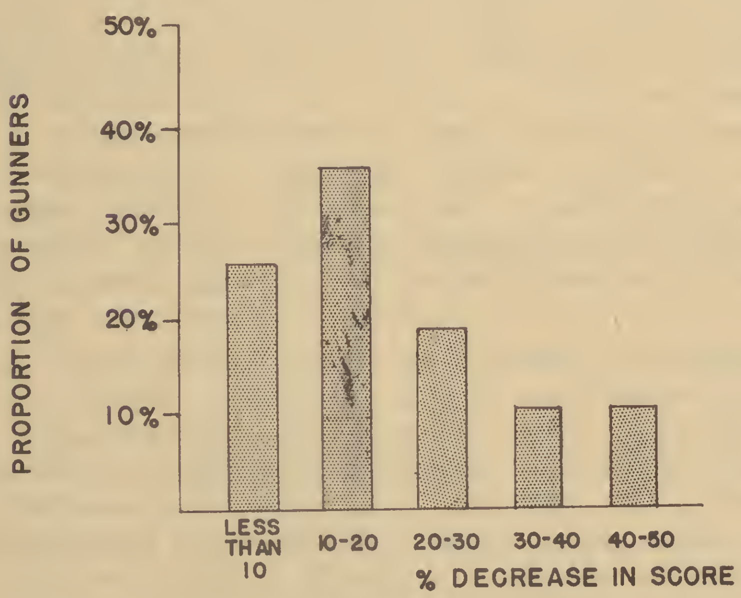
d. Subjects continue shooting until they feel they must plug in or the observer believes it advisable to administer oxygen. Usually two or three trials are sufficient to demonstrate impaired performance. If a man is off oxygen during only part of his last two-minute trial his record can still be used since the score consists of percent hits.

e. The scores for the last practice trial and last anoxia trial are compared. Scores are expressed in terms of proportion of hits out of total shots taken during the trial.

4. Results: Data for twenty-eight subjects are available. The percent scores of the present group all showed a decrease under anoxia. The range was -3% to -49% with an average change of -20%.

FIGURE I

Proportions of Gunners Showing Various Decreases in Shooting Ability when Anoxic at 22,000 feet



The duration of anoxia experienced by the subjects varied from one and three-fourths minutes to nine and one-fourth minutes with a mean duration of six minutes and eighteen seconds. It is interesting that in some cases even relatively short durations of anoxia produced measurable impairment.

Previous studies indicated that other psychological test situations did not show anoxia impairment consistently enough at 18,000 feet to be used for indoctrination (School of Aviation Medicine Research Report, Project No. 89, Report No. 3, 20 November 1943). The present data indicates that at a slightly higher altitude at least one type of psychomotor test will demonstrate individual decrements. The testing routine requires an appreciable amount of time, but results seem to justify it. Many of the trainees indicated that this was one of the most convincing illustrations of anoxia they had witnessed. A demonstration which clearly shows the less obvious effects of anoxia while a man superficially appears to be in good condition seems especially valuable for indoctrination. It should be emphasized, however, that in order to be successful the testing must be carefully controlled and conducted by well trained technicians.

Altitude Training Unit
Smoky Hill Army Air Field
Salina, Kansas

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REPORT OF ANOXIA FROM EIGHTH AIR FORCE

The patient was a navigator with 28 previous combat missions. He felt normal at take-off, but after about 30 minutes on oxygen and at an altitude of 17,000 feet, patient complained that he could only see the left half of aircraft in his formation, and left half of the "Blips" in the "G" Box. This was followed by a slight headache, nausea, then vomiting, and later by a severe headache and dizziness. Patient for a short time experienced a burning sensation beneath sternum. Patient continued on mission, remaining on oxygen for about six hours without any further increase in severity of these symptoms. He remained about the same until descent when visual defects disappeared at about 6,000 feet and vomiting disappeared at ground level. After mission patient felt extremely tired and exhausted. Diagnosis: Acute anoxia, manifested by homonymous hemianopsia, nausea and vomiting, chokes and exhaustion. Determination of visual fields about five hours after mission revealed concentric contraction, bilaterally. Visual acuity: OD 20/30 ≠ 4, OS 20/30 ≠ 4. Visual fields 24 hours later unchanged: OD 20/15, OS 20/15. The A-14 modified mask was apparently normal, but because of what seemed to be undue resistance to breathing, the A-12 Bendix regulator was replaced. The exact nature of the defect, if any, is not known. A walk-around bottle was used for ten minutes in an effort to relieve the condition but only aggravated it.

On one occasion six months ago he experienced similar attack with A-10 mask at 18,000 ft., lasting 30 minutes manifested by scotomas, headache, vomiting, and dizziness. Symptoms relieved by turning auto-mix to off position. Two months ago he experienced again similar symptoms with A-14 modified mask, lasting 30 minutes at 29,000 feet, manifested by scotomas, nausea, and vomiting, headache and pain in shoulder, relieved by turning auto-mix to off position.

CAPT. HERBERT C. ALLEN, MC
Squadron Surgeon, 333th
96th Bombardment Group (H)
APO 559

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BELIEVE IT OR NOT; BETTER NOT

Laredo Army Air Field, Tex. -- Cpl. Howard A. Searfoss, a student at the flexible-gunnery school here, made a routine visit to the low-pressure chamber and amazed attendants by going to a simulated altitude of 35,000 feet without benefit of oxygen. Searfoss' feat is rare in Army record; AAF medical authorities advocate the use of oxygen at 10,000 feet.

Searfoss, who comes from Wilkes-Barre, Pa., is no husky GI specimen. He is only 5 feet 4 inches tall and weighs 115 pounds. He volunteered to be a subject for study so fellow students might note the reactions of flight at high altitudes without oxygen.

Twenty-two minutes after the heavy door of the pressure chamber had closed, Searfoss was in a pressure equivalent to that at 18,000 feet. There was no apparent effect; he was able to write his name and serial number perfectly and do mental arithmetic problems, and his muscular coordination was good. The "flight" remained at this "altitude" for 12 minutes. At 23,000 feet Searfoss was still apparently normal.

At 27,000 and 28,000 feet Searfoss made two mistakes in spelling. Approaching 30,000 feet, he made several mistakes in simple addition and subtraction but corrected them himself. He even took exercises. He stayed at 30,000 feet for 23 minutes. During that time he could tie his shoe lace with very little trouble and was feeling very happy. He said he'd like to come to the pressure chamber every Saturday night for a cheap drunk.

At 32,000 feet, the "altitude" began to have its first real effect. Cpl. Searfoss' eyes became bleary and his coordination was poor. He told an oxygen-masked observer he was growing weaker and that he felt the need of oxygen.

The flight reached 35,000 feet and remained there for two minutes before a quick "descent" to 32,000. At this point the corporal complained of a pain in his shoulder (bends) and took oxygen for the first time. He was able to put on his mask, but the observer had to turn the oxygen valve for him.

The chamber was "dropped" quickly then, and Searfoss' limbs stiffened and severe tremors developed in both arms and legs. This shaking ceased below 15,000 feet. At "ground level" Searfoss felt weak and very excited. After receiving oxygen on a cot for a half-hour, he was taken to the station hospital for observation. He walked with steady step but appeared dazed. He was given more oxygen for another hour, spent a normal night and left the hospital next morning no worse for his experience.

From: "Yank" 30 June 1944

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EDITORIAL NOTES:

Additional regulators for use on the Linde oxygen manifold supplied with the Guardite chambers are in stock at Patterson Field and may be requisitioned directly from there. The right hand regulator bears the Stock Number 7800-687020 and the left hand regulator 7800-687000.

Most of the Altitude Training Units using Kinney oil-sealed pumps have had more or less difficulty as a result of the spraying of tricresyl phosphate over the surroundings. Many of the Units have developed more or less efficient baffle tanks to prevent this. If any of the Units care to submit drawings or descriptions of baffle tanks which they have found to be particularly effective they will be published in the Aviation Physiologists Bulletin for the benefit of all.